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SHORT AND SWEET

Does size matter?

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Abstract. For isolated objects in complete darkness, retinal image size contributes to distance judgments even if the true object size is unknown. Here we show that the same is true under more natural conditions. On a wide beach we positioned a red cube at 10–20 m distance and then asked subjects to walk to it while blindfolded. Subjects never had a close view of the cube and were unaware that on separate trials cubes with sides of 15 cm and 20 cm were positioned at the same locations. On average, subjects walked 1 m further after seeing the 15 cm cube than after seeing the 20 cm cube.

Keywords: size, depth, blind walking

Experiments conducted in very constrained environments, such as pointing at a single object in the dark, have shown that people rely to some extent on an object's retinal image size to judge its distance. They even do this for unfamiliar objects, which implies that they assume that some sizes are more likely than others (Collet et al 1991; Sousa et al 2011). As a consequence a small object is estimated to be further away than a large object, when they are actually at the same position. Is this just because there is little reliable information about distance in such environments? Does the size of an unfamiliar object matter when judging distances in a more natural environment?

One method that can be used to measure subjects' judgments of distances of up to 20 m (Loomis et al 1992; Thomson 1983), in both natural and more constrained environments (Creem-Regehr et al 2005; Philbeck and Loomis 1997), is blind walking. In our study four subjects had to judge the distance of an unfamiliar red cube that was placed in front of them at a distance of between 10 and 20 m on a wide empty beach in Schiermonnikoog, The Netherlands (figure 1). The subjects looked at the cube for a few seconds, after which they were blindfolded and had to walk to the position of the cube. The cube was removed after the subjects started walking so that they would not receive feedback if they bumped into it. The walked distance was measured with a tape measure. After each trial the subjects were walked back to the initial position while still blindfolded.

If size matters, they should walk further for a smaller object. We therefore presented two cubes (edges of 15 and 20 cm) at the same 15 distances. The 30 trials were presented in random order. At the end of the experiment the subjects were asked to estimate the size of the cube, which they had seen only from a distance, by indicating the length of the cube's side by the separation between their index fingers. This separation too was measured with a tape measure.

On average, subjects walked 1 m further when they had seen the smaller cube (15 cm) than when they had seen the larger cube (20 cm). The tendency to walk further for the smaller cube was consistent across subjects ($t_3 = 5.14$, $p = 0.01$; figures 2a and 2b). There are some clear differences in walked distances between subjects (eg the subject represented by the green dots underestimated the distances). These differences are consistent with the estimated cube sizes: subjects who assumed the cube to be smaller tended to judge it to be nearer (figure 2c).

Figure 1. [In colour online, see http://dx.doi.org/10.1068/p7324] One subject looking at the object before walking blindfolded to the position at which he saw it (photograph taken by Johanna Barnbeck).

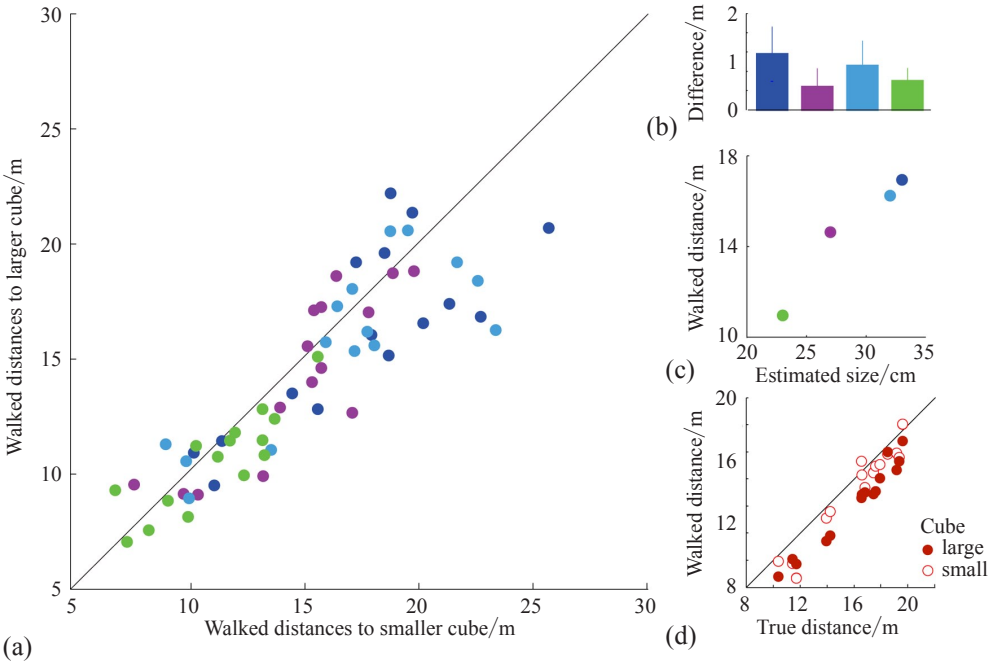

Figure 2. [In colour online.] (a) The distances walked to 20 cm and 15 cm cubes that were presented at the same location. Each point indicates the walked distances on two trials. Each subject is represented by a different colour. Subjects tended to walk further for the smaller cube (most points below unity line). (b) The tendency to walk further for the small cube than for the larger cube was found for all four subjects: bars show the average difference in walking distance (with standard errors). (c) The estimated object size correlates with the average walked distance. (d) On average, the subjects walked slightly less far than they should have for all target distances, especially for the larger cube (solid symbols).

After the experiment the subjects were shown the two cubes. Three of the four subjects were surprised to discover that more than one cube had been presented. The fourth subject (light blue in figure 2) believed that several cube sizes had been presented, although he had indicated only one size when he was asked to estimate the size of the cube.

We conclude that the size of the target object matters when judging its distance in a natural environment, meaning that retinal image size is used to estimate the distance of an unfamiliar object even when there are other cues available such as binocular disparities, height in the visual field, and surface texture gradients. Thus, even in a full cue environment size matters, so you should beware of unusually sized objects when walking on the beach.

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